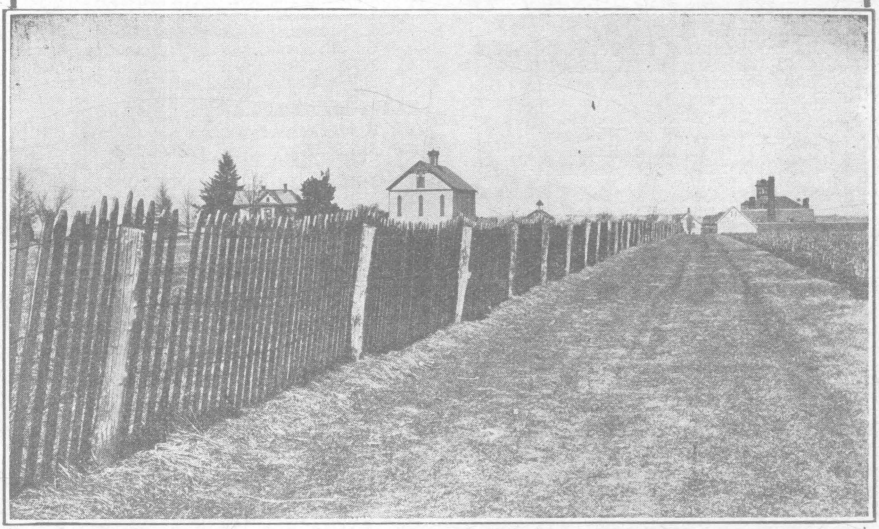
THE RELATIVE DURABILITY OF POST TIMBERS

OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., JUNE, 1910

BULLETIN 219



Section of a fence on the farm at the Ohio Agricultural Experiment Station

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[2]The U. S. Department of Agriculture, cooperating.

SIR:—I have the honor to transmit herewith and to recommend for publication as a bulletin of the Station the accompanying manuscript entitled "The Relative Durability of Post Timbers."

This bulletin, prepared by J. J. Crumley, assistant in forestry, during the period when the work was under my charge, is the result of extended investigations in this and other states regarding the relative durability of the kinds of timber most commonly used for posts. One object in going into other states in this work was to get data on some varieties of timber that have not been in use long in this state but are rapidly coming into general use and are very important in this investigation.

So far as known no work of this kind has ever been undertaken on so large a scale. While this fact alone is not urged as a reason for drawing definite conclusions, it may be taken as evidence to establish with considerable certainty the relative durability of the kinds of timber named in the investigations.

The striking variability of wood as to durability under varying conditions makes it plain that the number of observations count for a great deal. On the whole, the results cannot fail to be of value, both as to the facts stated, and suggestions which may be aroused in the minds of readers.

Respectfully,

W. J. GREEN, *Consulting Forester.*

CHAS. E. THORNE, *Director.*

BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 219 JUNE, 1910

THE RELATIVE DURABILITY OF POST TIMBERS

By J. J. CRUMLEY

The various state Experiment Stations and the Forest Service at Washington are continually receiving inquiries concerning the durability of timbers in the soil. The farm journals throughout the country are also frequently called upon to answer questions on this subject.

In the forestry exhibit at the Ohio State Fair, in 1906, and also in 1909, there was a group of eight specimens of wood labeled "Post Timbers." During the time that these specimens were on exhibition there were six different varieties of wood pointed out with the expression "That is the best for posts." These six were yellow locust, red cedar, hardy catalpa, Osage orange, mulberry and chestnut.

While the data published herein were being collected, men were found living on adjacent farms—one believing very steadfastly that posts should be seasoned before they are put in the ground, the other just as firm in his belief that they should be set green; and again, one believing that posts should be set with the top or

small end in the ground, that is, the opposite to the way they grew in the tree, the other that they should be set with the top or small end up. These men were probably speaking from an experience of many years. Such circumstances may be duplicated over and over. The above and scores of other observations of this kind seem to indicate that there is need of careful and extended investigation along this line.

The time has come when we must make a clear distinction between the qualities of post timbers. Timber is getting more and more scarce and prices keep increasing, and the future purchaser must know what he is buying. Hundreds of farmers in our state are beginning to set out trees. More of them are planting with a view to growing posts than for any other purpose. Surely then we should understand as clearly as possible which timber will produce the most durable post. We should also consider carefully the rate of growth, pests, and adaptability to soil, climate, etc.

The material published in this bulletin has been obtained from the examination of 292 fences containing 30,160 posts. These fences are situated in Ohio, Indiana, Illinois, Kansas and Texas. The counties in Ohio in which fences have been examined are: Warren, Greene, Clark, Guernsey, Adams, Ross, Wayne, Fulton, Montgomery, Champaign, Morrow, Knox, Van Wert, Preble, Williams, Putnam, Union, Miami and Franklin.

The object in going outside of the state was to get data on two kinds of timber, the hardy catalpa and the Osage orange, that have not been used very long in this state, but are very important in the consideration of post timbers. Two summers were spent in the Wabash Valley, the home of the hardy catalpa. Here posts were studied that were cut from trees that grew in the forest. A portion of one summer was spent in Kansas, examining catalpa posts cut from trees that grew in cultivated groves in the Farlington, Hunnewell and Munger plantations. A portion of one summer was spent in Texas, examining Osage orange posts.

In each of these states a few fences of oak, locust and mulberry were examined for sake of comparison, to use as a kind of measuring stick in case the soils or climate might prove more or less severe on posts than in Ohio.

The manner of collecting this material was as follows: A fence of considerable age having been found, usually old enough to contain rotten posts, it was examined closely, the data being taken down on a blank form. One of these forms is given below filled out.

TABLE I

OHIO AGRICULTURAL EXPERIMENT STATION

DATA CONCERNING FENCE POSTS

November 25, 1906.

Owner Edwin Woods P. O. Lebanon, Ohio

County Warren Township Union

Location 3½ miles southeast of town. Fence is the east and north sides of the "spring field."

Kind of Fence Board and wire.

Direction N-S and E-W.

Soil Clay loam, rather thin.

Drainage Good.

Kind of Posts Yellow locusts.

Age 20½ years. Set in spring of 1886.

Time of Cutting

Seasoning Seasoned.

Size of Posts Small to medium.

Distance Apart 8 feet.

Number Sound	126 (81 percent)	u s 71 (82½ percent)	d s 26 (66⅔ percent)
Number Rotten	30 (19 percent)	u r 15	d r 13
Total Number	156	86	39

Remarks: In case of 31 of the posts it was not evident whether they were set top up or top down. Posts came from Kentucky. Were made from large trees. Flat bark posts and triangular heart posts are frequent. Posts next to bark show better record than the triangular ones split from center of tree.

These are from same lot of posts as those on the W. and S. side of same field (recorded in Loc. No. 9, 46), which were set one year earlier and have a larger percent of sound posts. Size and selection caused the difference.

The most of these items are taken from the fence itself and its surroundings. "Time of Cutting" and "Seasoning" can not always be obtained. The "Age" is especially important and was in each case obtained with the utmost care.

When the above items were obtained, the fence was then examined post by post and the condition of each was set down in order as indicated in the following table.

TABLE II

OHIO AGRICULTURAL EXPERIMENT STATION

POST TO POST RECORD

(u)—set top up. (d)—set top down. (s)—sound. (f)—fair. (p)—poor. (r)—rotten (h)—heart post. (b)—post next to bark. In summary, (f) is classed with (s) and (p) with (r).

Owner Edwin Wood

Beginning at S. E. cor. of field, go north.

1	d s	d s	u s	u s	s	s
2	s	d r	u s	u s	u s	d s
3	s	u s	u s	u s	s	d r
4	u s	u r	u s	u r	d s	u s
5	u s	d r	u s	u p	u s	d p
6	s	s	u s	d f	u s	u s
7	u f	p	d s	d s	u f	d f
8	u s	u s	u s	u f	u s	Cor. N. W.
9	u s	s	u s	d f	s	
10	u s	u s	u s	u r	u r	
11	u s	u s	u s+	u s	d s	d s 26
12	u s	u s	o s	u s	d r	d r 13
13	s	u s	d s	s	d f	39
14	u s	u s	u f	u s	u s	
15	d s	r	s	u r	u s	u s 71
16	u s	d r	d s	u r	u s	u r 15
17	d s	u s	u r	u p	d s	86
18	u s	d s	u s	d r	d r	
19	u r	u s	s	d s	u s	
20	s	d s	u s	u f	u s	
21	u s	u s	s	u p	d r	
22	s	s	u s	u r	d r	
23	s	u f	u s	s	d f	
24	s	u f	d s	u s	u s	
25	f	d p	d s	u s	s	
26	s	d s	s	d s	u r	
27	u s	u s	u s	s	d p	
28	s	u s	u r	s	u s	
29	s	d f	u f	s	d r	
30	u s	u s	u s	d s	u r	

+—N. E. Cor.

In this table, each column contains the record of 30 posts. That is, the one at the head of the second column is the thirty-first post in the fence, the one at the head of the third column is the sixty-first, etc. The whole fence contains 157 posts, one of which, No. 72, is oak, leaving 156 locusts to be counted in the summary.

One interesting item that this fence furnishes is the relative condition of posts set with the top down and those set with the top up. Of those set top down, there are just half as many rotten as

there are sound; of those set top up, there are only about one-fifth as many rotten as there are sound. Sometimes a post does not show in which position it has been set. There are 31 of such in this fence.

It will be noticed under "Remarks," Table I, that this fence has a number of triangular heart posts and a similar number of thin, flat posts that have the heart split off. The most of the rotten posts in the fence are found among the heart posts and nearly all of the thin, flat ones are sound. The same feature was found in many other fences, and is true of several kinds of timber.

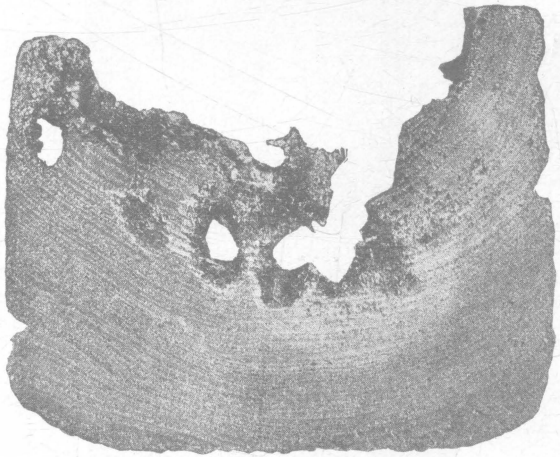

Fig. 1

Fig. 2

Plate I. Cross-sections of posts showing the tendency to rot at the heart first. Fig. 1 is catalpa. Fig. 2 is white cedar.

Plate II. Longitudinal section of a locust post showing tendency to rot at heart first. See pages 613, 614, 622, 625.

The data in detail of one more fence are given below on account of some individual items and for reference later.

TABLE III

OHIO AGRICULTURAL EXPERIMENT STATION

DATA CONCERNING FENCE POSTS

November, 1907.

Owner John Hyde P. O. Yellow Springs, Ohio.

County Greene Township Miami

Location One mile S. of town on W. side of woods, on Xenia pike.

Kind of Fence Picket

Direction N-S.

Soil Clay-loam, limestone.

Drainage Good.

Kind of Posts White oak.

Age 13½ years; set in spring of 1894.

Time of Cutting Winter.

Seasoning Green.

Size of Posts 5 to 7 inch face.

Distance Apart 10 feet.

Number Sound 152 3 s 87 4 s 29

Number Rotten 100 3 r 52 4 r 33

Total Number 252 139 62

Remarks: 60% s 63% s 47% s

TABLE IV

OHIO AGRICULTURAL EXPERIMENT STATION

POST TO POST RECORD

(u)—set top up. (d)—set top down. (s)—sound. (f)—fair. (p)—poor, (r)—rotten. (h)—heart post. (b)—post next to bark. In summary, (f) is classed with (s) and (p) with (r).

Owner John Hyde

Beginning at N. W. cor. of woods, go south.

1	1us	3 f	4dr	>1us	3df	3uf	3 s	3 r	4dr
2	2us	2ds	3us	1 s	3 s	4ds	3us	3uf	3 r
3	3 f	4ur	3df	3 r	3 s	4ds	3 f	3 r	4uf
4	2 r	4dr	3us	3 r	3 p	3 s	3 s	3ur	3 s
5	2up	3 f	3 f	3 s	2dr	4us	3us	3 s	3 p
6	2df	2us	3 s	4ur	4ur	4ds	4dr	3 r	3 p
7	2ds	2 f	4us	3ds	3 f	4ds	4dr	3dp	4dp
8	2df	2 s	4us	4ur	4ur	3 p	3dr	3 s	3 r
9	2ur	2uf	4 r	4ur	3 s	4ds	4ur	3 r	3 f
10	2ur	2 s	4ur	4ur	3 f	4us	3 s	3dp	4 s
11	2ds	3 s	4us	3 f	4ur	4us	3us	3 s	3 p
12	2ur	2 s<	4df	3dr	4ur	4dr	3 r	3 s	3dr
13	2up	3 p	3 s	3uf	3 s	tree	3 r	3 r	3 s
14	2dr	3 r	4dr	2 s	2ds	3us	3 r	3 r	3 p
15	2us	3 s	4dr	3 s	3p<	4 s	3 r	3 r	3 f
16	4us	3uf	4ur	3us	4ur	4ds	3 r	3 s	3 f
17	2ur	3 f	tree	3us	sas. r	2us	3ur	3 r	4ds
18	3ur	3 f	3 p	3 s	2df	4uf	3 s	3ur	1ds
19	3ur	4dr	3 s	3 s	2ds	4ds	3 s	3 r	
20	2ds	4ur	3uf	3 s	2 s	3ds	3 s	3 r	
21	2uf	2ur	4us	2 r	2 s	3dp<	3 s	3ur	
22	2ds	2dr	3 s	4ds	2ds	4ds	3us	4dr	
23	2uf	2 p	3ds	3 r	sas. r	3 s	3 s	4ur	
24	2us	3 r	3df	3 r	sas. f	3us	3 f	4ur	
25	2ur	3 s	3 s	3 s	sas. r	3 r	3us	3 r	
26	3 r	4up	3dr	3 f	2ds	3 f	3 s	4dr	
27	2ds	4ds	3 f	3df	3us	tree	3uf	3 s	
28	2 s	4ur	3us	3 s	4us	3 s	3uf	4us	
29	3ur	4 s	4dr	3 s	4dr	3 s	3 f	4us	
30	2us	3 r	3 r	3 s	3us	3dp	2ds	4df	

>—a gate. <—a culvert.

Tables III and IV are the opposite sides of the same leaf of a blank book in which these data are taken. There are two pages of this kind for every fence that has been examined.

In Table IV, the shape of each post is described in order by the figure standing before each set of letters. The figure 1 stands for a round post, see Fig. 1 in accompanying cut; 2 for a wedge shaped post extending from the bark to the center of the tree, see Fig. 2; 3 for one that has had the heart split off, see Fig. 3; 4 a heart post

with three corners, see Fig. 4. For example, post number 15 is a wedge shaped post that extended from the bark to the center of the tree, it was set "top up" and is sound. Number 61 is a three-cornered heart post, set "top down" and is rotten. Number 62 is a post next to the bark but with the heart split off, is set "top up" and is sound.

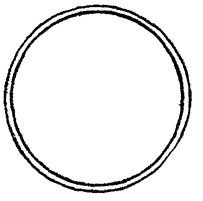

Fig. 1

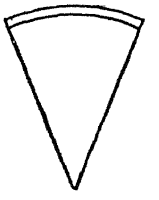

Fig. 2

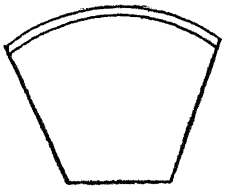

Fig. 3

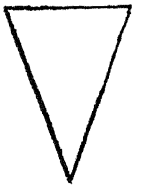

Fig. 4

It will be noticed here that 63 percent of the posts next to the bark are sound, while only 47 percent of the three-cornered, heart posts are sound.

This characteristic of rotting at the heart first has been observed to a marked extent in the locust, the oak, the hardy catalpa, the white cedar, and to some extent in the red cedar.

In the Wabash Valley, two of the most common shapes of catalpa posts are quarters and halves split from small trees; and those where decay has set in are very frequently found in the shape of a quarter-circle or a half-circle next to the sap wood or bark. The white cedar post, so common along the railroads, is frequently found in the shape of a half-circle a few inches below the top of the ground. See Plates I and II.

This fact may come as a surprise to many; indeed, some have already expressed their surprise at it and still others have refused to believe it. But when we come to look for the cause, it is not quite natural and what might be expected? Let us take for example an oak tree: the oak posts in the fence recorded in Tables III and IV have from five to seven inches face along the medullary rays. This indicates that the trees from which they were split were from 20 to 30 inches in diameter. White oak trees this size are from 150 to 200 years old. Now the only part of a tree that is alive is the part next to the bark. That part of the tree, therefore, from which these three-cornered posts were split, had been dead a hundred years or more when the tree was cut. Then, too, the center of the tree contains numerous little knots, where branches dropped off in the early life of the tree. Some of the branches in falling leave perfectly sound knots, but others offer opportunities for germs and mild decay to set in. This decay may not make any visible progress before the sap wood closes over the defect left by the falling branch.

but its effects will be there, and though it may not cause a rotten place by the time the tree is cut, it may cause the wood for some distance above and below to be a little too dark; that is, instead of bright, reddish straw-color, it will be nearer a maroon or even almost brown. Such wood may be firm and strong, and posts split from it may pass for sound ones, when as a matter of fact this hidden decay has already set in. This quality of post is by no means rare in the fences examined for the preparation of this bulletin. On the other hand, the posts split from the outside of the tree have not been standing in the tree so long, have been formed after the tree was a foot or more in diameter and had a smooth trunk, and the wood therefore is clear of knots and not subject to infections by being exposed to the air through knot holes.

It must not be understood that the white sap wood is referred to here as being durable. In estimating the size of a post split from the outside of the tree, as much post only should be counted as there is heart wood. The wood of good quality referred to here is the heart wood that lies just beneath the sap wood, as compared with the heart wood at the center of the tree.

This same tendency to rot at the heart first is seen in hollow trees and trees doted at the heart in our native woodlands.

On the following pages are given summaries of the 292 fences examined. These are grouped according to the kind of timber from which the posts were made, and six other items are given, viz.: size of posts, age or time of service, the number sound, the number rotten, the total number, and the percent of sound posts. These seven items are obtainable for the most part from every fence examined and are items vital to all. There are other items in the data recorded that are of supreme importance for certain fences, but are not common to all the fences alike. These will be discussed in the comments on the pages following the tables.

The first column of figures is simply the order of the fences of each kind of timber. The second column designates the order of the fences in the six books in which the data were recorded. The name and address of the owner of any of the fences can be obtained from those six books.

OSAGE ORANGE

		Size	Age	No. Sound	No. Rotten	Total	Percent Sound
	Book No. 1	Inches					
1	11	2-3	15	100	0	100	100
2	14	3 5	16	109	0	109	100
3	19	3-5	21	74	0	74	100
4	21	3-5	28	53	1	54	98
5	51	2½-4	26	28	3	31	90⅓
	Book No. 3						
6	16	2-4	15	50	0	50	100
7	26	3-5	22-12	79	0	79	100
	Book No. 4						
8	14	3-4	15	54	0	54	100
	Book No. 5						
9	1	3-5	48	104	0	104	100
10	2	2-5	33	494	2	496	99⅗
11	3	2-5	34	531	9	540	98+
12	4	5	30-35	68	2	70	97
	Book No. 5						
13	5	5-6	30	44	1	45	98
14	6	3-6	29½	29	0	29	100
15	7	2-4	28½	310	2	312	99
16	8	3-4	50	24	0	24	100
17	9	3-5	30+	126	4	130	97
18	10	4-6	40	90	0	90	100
19	11	3 4	36	38	1	39	97
20	12	6-12	58	11	0	11	100
21	12	6-12	48	28	0	28	100
22	13	1-3	40	214	7	221	97
23	14	3-5	34	29	1	30	97
24	15	6-10	49	18	0	18	100
25	16	4×4	33	17	0	17	100
26	17	3-5	38	68	4	72	94
27	18	3-5	33	92	2	94	98
28	19	3-5	40+	49	0	49	100
29	20	3-5	28+	61	4	65	94
30	21	6×6	12	332	0	332	100
31	28	3-5	21	43	0	43	100
32	29	3-4	7	130	0	130	100
33	30	2½-3	7	40	0	40	100
	Book No. 6						
34	32	2½-4	25	27	0	27	100
35	33	3-5	47	41	0	41	100
36	34	2½-4	25+	41	0	41	100
37	35	2-4	30	42	0	42	100
38	36	3-4	10+	53	0	53	100
39	37	2½-4	17	70	0	70	100
40	38	3-4	22	31	0	31	100
41	39	3-5	30	67	0	67	100

LOCUST

		Size	Age	No. Sound	No. Rotten	Total	Percent Sound
	Book No. 1						
1	12	Medium	14	23	1	24	96
2	23	"	31	22	3	25	88
3	24	Small	5	26	0	26	100
4	25	"	6½	36	8	44	82
5	26	Medium	31	45	6	51	88
6	30	"	24	67	0	67	100
7	31	"	32	115	51	166	69
8	45	"	20	126	30	156	81
9	46	"	21	143	13	156	91½
10	47	"	20	43	8	51	84
11	48	"	11	13	1	14	93
	Book No. 3						
12	3	Medium	20	111	21	132	84
13	7	Large	60?	20	0	20	100
14	8	Medium	60?	12	1	13	92
15	9	Large	14	63	5	68	93
16	15	Medium	8	59	0	59	100
17	19	"	30	55	6	61	90
18	20	Large	22	54	3	57	95
19	39	Medium	22	88	34	122	72
20	43	"	40	20	4	24	83
21	48	"	8	37	4	41	90
	Book No. 5	Inches					
22	27	4-6	42	27	8	35	77
23	27	4-6	25	25	1	26	96
24	31	3-5	9	32	12	44	73
25	32	3½-6	16	1173	98	1271	92
26	33	4-5	15?	147	2	149	98½
27	34	4-6	16	568	57	625	91
28	35	4-6	15	174	6	180	96⅔
29	36	5	17	64	0	64	100
	Book No. 6						
30	6	4-6	½	13	0	13	100
31	12	4-6	6	56	0	56	100
32	41	5-9	42	157	17	174	90
33	42	6-8	18	87	7	94	92½
34	43	4-6	22	35	0	35	100
35	44	4-6	22	68	0	68	100
36	45	4-5	29	74	49	123	60
37	46	6-7	35	62	25	87	71
38	51	4-7	17	570	70	640	89

RED CEDAR

	Book No. 1	Inches					
1	29	4-7	35	24	27	51	47
2	48	5-7	11	14	5	19	74
	Book No. 2						
3	44	5-8	50	34	19	53	64
	Book No. 4						
4	1	2-5	42	81	59	140	58
5	5	4x4	16	141	4	145	97
6	6	4-6	30	41	8	49	84
7	28	5-8	36	37	29	66	56
8	29	5-7	20	26	3	29	90
9	30	5-6	18	39	6	45	87
10	31	5-8	40+	9	8	17	53
11	32	5-8	30	48	13	61	79
12	33	5-8	50	4	9	13	31
13	34	5-7	18	71	22	93	76+
14	35	4-6	45?	20	30	50	40
15	36	5-8	40	57	19	76	75
16	37	5-8	40	102	89	191	53
17	39	8x11	63	4	4	8	50
18	41	5-9	36+	73	96	169	43
19	42	7-8	40+	11	38	49	22½
20	43	3x6	40	15	3	18	83
21	44	4-6	7	37	3	40	92½
22	45	5-7	12	68	0	68	100
23	46	5-7	14	128	2	130	98½
24	47	4-6	10	143	0	143	100
25	48	4-7	8	136	0	136	100
26	49	6x8½	62	11	2	13	85
	Book No. 5						
27	25	5-7	?	65	4	69	94
	Book No. 6						
28	9	4x4	30	38	7	45	84
29	10	4x4	30	29	16	45	64
30	11	4x4	30	35	5	40	87½
31	47	5	7	16	0	16	100
32	48	5	5	61	0	61	100
33	49	3-4	2	25	0	25	100

MULBERRY

		Size	Age	No. Sound	No. Rotten	Total	Percent Sound
	Book No. 1	Inches					
1	20	4-6	19	29	11	40	72½
2	38	4-6	19	40	2	42	95
3	40	5-7	13	11	2	13	85
4	41	4-6	20	57	31	88	65
	Book No. 2						
5	29	4-7	30	22	14	36	61
6	20	4-7	16	4	6	10	40
7	19	4-7	24	9	5	14	64
8	18	4-7	16	31	29	60	51⅔
9	17	4-6	24	10	7	17	59
10	11	4-6	20	4	2	6	66⅔
11	3	4-7	15	6	2	8	75
	Book No. 3						
12	4	4-7	37	41	8	49	84
13	26	4-6	22	11	2	13	84½
	Book No. 5						
14	24	4-5	?	24	7	31	77
	Book No. 6						
15	19	4-6	25	95	5	100	95

WHITE CEDAR

	Book No. 1						
1	20	4-6	19	31	9	40	77½
	Book No. 3						
2	21	4-7	17	122	44	166	73½
3	22	4-7	17	174	72	246	71
4	23	5-7	17	51	15	66	77
5	24	5-7	18	31	39	70	44½
6	25	5-7	20?	59	47	106	56
	Book No. 6						
7	14	5-7	15	84	7	91	92
8	23	4-5	25	33	26	59	56
9	24	4-5	25	53	17	70	76
10	25	6-9	8	738	12	750	98½
11	25	6-9	8	712	38	750	95
12	26	6-9	8	195	15	210	93
13	26	6-9	8	178	32	210	85
14	28	5-7	11	83	16	99	84

CATALPA

	Book No. 1						
1	1	6-9	25	14	7	21	66⅔
2	3	5x5	11	0	11	11	0
3	4	4x5	12	4	11	15	27
4	5	6-9	17	55	34	89	62
5	6	5-7	18				40
6	7	6-9	34	9	2	11	82
7	9	4-6	20	30	30	60	50
8	10	5-6	31	23	3	26	88½
9	12	5-6	14	16	8	24	66⅔
10	13	6-9	14	43	34	77	56
11	16	5-6	27	8	10	18	44½
	Book No. 2						
12	42	5-6	5½	3	9	12	25
13	39	5-6	15	256	40	296	86½
14	38	5-6	21	47	31	78	60
15	37	5-6	20	30	13	43	70
16	36	4-6	14?	97	10	107	91
17	35	5-6	16	30	17	47	64
18	35	5-6	15	6	5	11	54½
19	34	5-6	13	29	13	42	69
20	33	5-6	17	55	25	80	69
21	32	5-6	17	22	15	37	59
22	31	5-6	25	57	28	85	67
23	30	5-6	18	28	31	59	47½
24	29	5-7	30	19	17	36	53
25	28	5-6	13	17	23	40	42½
26	27	5-6	22	26	29	55	47
27	26	5-6	13	37	49	86	43
28	25	5-6	16	2	21	23	9
29	24	5-6	7	151	16	167	90½
30	23	5-8	25	9	32	41	22
31	22	5-6	16	21	25	46	46
32	21	5-6	16	38	27	65	58½
33	20	5-6	16	39	7	46	85

CATALPA—Concluded

		Size	Age	No. Sound	No. Rotten	Total	Percent Sound
	Book No. 2	Inches					
34	19	6-9	24	25	23	48	52
35	17	5-6	24	11	17	28	39
36	16	5-6	13	19	12	31	61
37	15	4-6	27	10	14	24	41⅔
38	14	6-9	18	47	42	89	53
39	12	6-8	21	34	17	51	67
40	13	5-6	15	53	3	56	95
41	11	6-8	20	56	17	73	77
42	19	6-8	23	59	58	117	50½
43	9	5-8	14	103	24	127	81
44	8	5-6	16	67	12	79	85
45	7	4-5	30	27	185	212	13
46	4	5-6	15	69	54	123	56
47	3	5-6	15	126	77	203	62
48	2	5-6	19	104	42	146	71
49	2	5-6	17	92	15	107	86
50	1	5-6	18	96	56	152	63
51	48	5-6	1	36	0	36	100
52	40	5-8	39	12	53	65	18½
	Book No. 4						
53	1	3½-6	7	93	7	100	93
54	2	3½-6	7	126	4	130	97
55	3	3-5	7	463	45	508	91
56	4	3-5	7	470	70	540	87
57	5	3-5	6½	220	21	241	91
58	6	3-5	6½	175	9	184	95
59	7	3-4½	2	100	0	100	100
60	8	3-5	6½	103	8	111	93
61	9	4	3	100	0	100	100
62	10	4	3	173	2	175	99
63	11	4-5	3	104	0	104	100
64	12	4-5	3	212	3	215	99
65	13	4-6	6	604	22	626	96½
66	14	3-4	3	136	2	138	98½
67	15	4-5	4	138	0	138	100
68	16	3-4	16	46	12	58	79
69	17	2½-4	20	11	26	37	30
70	18	2½-4	14	91	22	113	81
71	19	4	5	181	110	191	95
72	20	2-3	6½	270	150	420	64
73	21	2-3	4½	362	18	480	75
74	22	2½-3½	5½	208	28	236	88
75	23	2½-3½	5½	186	15	201	92½
76	24	2½-3½	5½	73	7	80	91
77	25	2½-4	9	592	188	780	76
78	26	2½	5½	39	13	52	75
79	27	4-5	3½	538	2	540	99⅔
80	28	2½-3	8	119	25	144	83
81	29	3-4	6	68	10	78	87
82	30	3½-5	6	830	20	850	98
83	31	4-5	6	684	24	708	96½
84	32	4-5	¼	60	0	60	100
	Book No. 6						
85	1	5-6	4	85	0	85	100
86	2	3-5	11	30	0	30	100
87	3	4-6	8+	12	4	16	75
88	4	5-7	6	28	4	32	87½
89	5	5-7	11	33	0	33	100
90	6	4-6	½	73	0	73	100
91	7	4-5	6	34	0	34	100
92	12	4-6	6	25	0	25	100
93	13	3-4	11	13	3	16	81
94	50	5-7	11	8	10	18	45
95	50	5-7	11	27	16	43	63

CHESTNUT

		Size	Age	No. Sound	No. Rotten	Total	Percent Sound
	Book No. 1	Inches					
1	32	5-6	9	15	3	18	83⅓
2	39	5-6	11	57	24	81	70⅓
3	39	5 6	7	37	3	40	92½
4	44	5-6	9	116	49	165	70
5	53	5-6	9	38	7	45	84½
6	54	5-6	8	9	5	14	64
	Book No. 3						
7	10	4-6	13	61	17	78	78
8	11	5-6	13	46	14	60	77
9	12	5-7	16	171	102	273	62½
10	13	5-6	13	77	33	110	70
11	14	5-6	13	50	51	101	50
12	18	5-6	28	8	8	16	50
13	27	5-6	11	157	74	231	68
14	50	5-6	13	22	36	58	38
15	51	5-6	12	36	34	70	51½
	Book No. 5						
16	22	5-6	12	42	11	53	79
17	23	5-8	8	63	4	67	94
	Book No. 6						
18	8	3-5	10	43	19	62	69

OAK

	Book No 1						
1	27	5-6	12	19	2	21	90½
2	28	5-5	9	57	40	97	59
3	32	5-6	9	14	3	17	82
4	33	4-5	17	38	30	68	56
5	34	4-5	16	26	53	79	33
6	35	4-6	14	37	12	49	75½
7	36	4-6	14	49	21	70	70
8	37	4-6	20	21	3	24	87½
9	40	4-6	13	49	18	67	73
10	41	4-6	20	10	21	31	32
11	42	4-6	16	23	27	50	46
12	43	4-6	8	43	13	56	77
13	50	4-6	12	155	95	250	62
14	51	4-5	23	27	3	30	90
	Book No. 2						
15	34	4-6	13	25	37	62	40
16	25	4-6	16	7	13	20	35
17	11	4-6	20	21	27	48	44
18	45	5-7	13	152	100	252	60
19	45	5-7	13	187	105	292	64
	Book No. 3						
20	2	4-6	25	18	18	36	50
21	17	4-6	15	18	0	18	100
22	47	4-6	10	53	22	75	71
23	50	4-5	13	5	8	13	38½
	Book No. 5						
24	26	3-5	18	7	22	29	24
	Book No. 6						
25	20	4-5	25?	43	14	57	75½
26	27	4-5	8	31	15	46	67
27	40	5-6	18	33	3	36	92
28	45	4-5	29	11	13	24	46

HONEY LOCUST

	Book No. 3						
1	17	4-6	15	15	29	44	34
	Book No. 6						
2	15	6-8	4	83	0	83	100
3	16	5-8	4	24	0	24	100

SASSAFRAS

	Book No.6						
1	17	5 6	4	57	0	57	100

BLACK ASH

	Book No. 6						
1	18	5-6	2	28	0	28	100
2	21	6-8	7	38	20	58	65½
3	22	6-8	6	17	10	27	63
4	29	6-7	8			*	†
5	30	6-8	9+			*	†
6	31	5-7	4½	14	2	16	87½

*Several hundred.
†Very few.

COMMENTS ON A FEW OF THE ABOVE FENCES THAT HAVE SOME POINT OF SPECIAL INTEREST

OSAGE ORANGE, No. 5. These posts were made from a hedge that had been kept cut back about 4 feet high for a number of years. It was allowed to grow ten or fifteen years and was then cut down at the ground and the larger ones were made into posts.

Several of these posts had defective places about 4 feet from the big end, caused by cutting the hedge back year after year at this point. The posts were set with the small end down. This put the defective place just beneath the top of the ground. The three poor or rotten posts failed at this point.

OSAGE ORANGE, Nos. 9 TO 30. These fences are in Texas. The majority of the posts are split, some are round, a few are sawed and hewed.

Nos. 20 and 21 are blocks used for the foundation of a house. These are from 6 to 12 inches in diameter. No. 24 is a lot of long posts used to support a shed around three sides of a barn. They are 6 to 10 inches in diameter. The rest are posts in ordinary fences. They range in size from 2 to 6 inches in diameter, the majority of them between 3 and 4 inches in diameter.

OSAGE ORANGE No. 29. This fence was built before barbed wire came into general use. Small holes are bored about nine inches apart along one edge of the posts. Smooth wire was fastened in these holes in such a way as to make loops (see Plate VIII). Rails split from the Osage orange tree are inserted into these loops. This makes a fence in which there is nothing but Osage orange wood and No. 9 wire. The present owner bought the farm 28 years ago. He was acquainted with it some 12 or 15 years before he bought it. The posts were in service and looked very old the first time he ever saw them.

The writer, while in conversation with the owner of fence No. 19, asked him if there was a good market for posts in that vicinity. He said they were not as ready sale as they used to be. When asked for the cause of this he replied: "Well the country was all fenced 30 to 50 years ago and we do not need any more posts."

Any one who drives about over that part of the country must conclude that this was not far from the truth, for the posts in most of the fences are rather ancient looking, frequently being in a large measure covered with moss and lichens.

This timber is certainly one of extremes. Besides its remarkable durability in the soil, it is just as remarkable in its standing qualities when seasoned, and in its elasticity.

The man just referred to above has a wagon made of Osage orange. He bought this wagon second hand, 40 years ago. Neither wheel has ever had a tire shrunk and the tires are as tight today as they were the day they were put on. The wheels, when struck a sharp blow, ring as if they were one solid piece of metal.

The wood seems to have been named from its elastic properties. The name is composed of three French words: "*bois*", wood; "*de*", "of" or "for"; and "*arc*", a bow, thus *bois d'arc* means wood for the bow. In this bulletin the term "Osage orange" is used because that name seems to be more widely understood in this state, although "*bois d'arc*" is the name almost universally used in the south-west, where the tree is native.

A well digger at Yellow Springs, Ohio has a drill that weighs about 500 pounds. His machine is constructed in such a way that, when the drill falls, the cable that supports it is stretched just as the drill strikes. This cable is

fastened to the end of a pole which must be elastic and must sustain a weight of 100 to 500 pounds. The toughest white oak or hickory in this position lasts about three months. The Osage orange pole that he has there at present has been there three years and shows no sign of weakening.

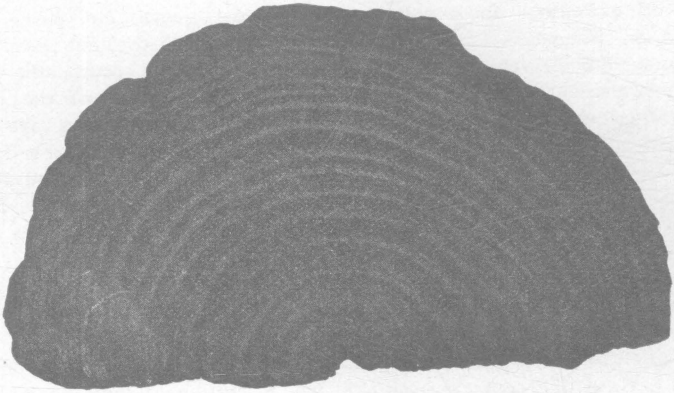

Fig. 1

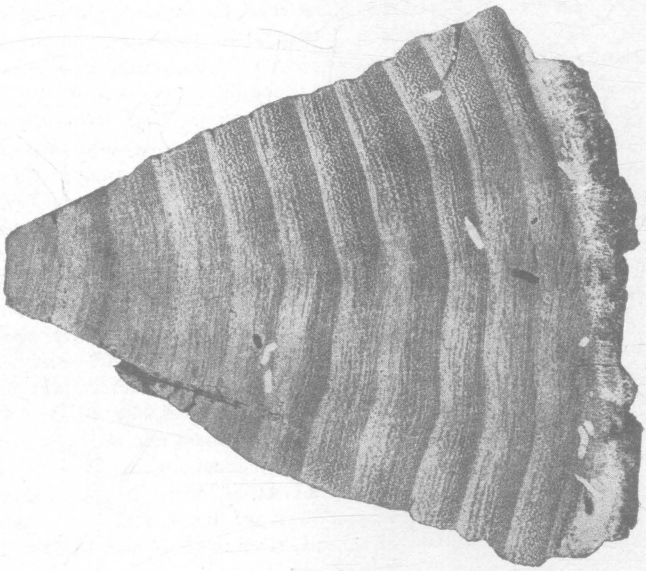

Fig. 2

Plate III. Fig. 1, Cross-section of a locust post that was sound after 31 years of service in the soil. Note how close the annual rings are. Fig. 2, Cross-section of a locust post that had rotted off in five years. Note how large the annual rings are. See page 622.

LOCUST No. 1. This is a line fence between two farmers. One man furnished locust posts, the other hardy catalpa. The posts were set alternate. Of the 24 locusts, 23 are sound; of the 24 catalpas, 16 are sound. Both kinds were seasoned when set. The posts of each kind were of fair quality except post No. 20 of the locusts. It was small and worm eaten.

LOCUST Nos. 4 AND 5. Thirty-one years ago (from the time these two fences were examined) the owner went to a locust grove, cut posts and built fence No. 5. Six years ago his son went to the same grove, cut posts and built fence No. 4. The 31-year-old fence has 88 percent sound posts, the 6-year-old has only 82 percent sound. In the 6-year-old fence, the most of the posts show very rapid growth, especially near the heart; the annual rings are from one-fourth to three-fourths of an inch thick. Many of the posts had a dark brown color, rather than a bright straw color, and a few were even doted at the heart when set. Further investigation showed that these posts were made from trees that had grown from stumps from which the posts for the older fence had been cut 25 years before. (see Plate III).

The 6-year-old fence was examined again about two and a half years later, that is when it was nearly nine years old, and was found at that age to be only 73 percent sound. It is recorded in locust fence No. 24.

LOCUST Nos. 8, 9 AND 10. These three fences furnish some very interesting data. First, it will be noticed that No. 9, which is one year older, has 91½ percent sound posts, while the other two have only 84½ percent and 81 percent sound. All three fences are made from the same lot of posts. Selection alone is the cause of this difference. The first 75 posts in fence No. 9 are along a line between two farms, and the man who built the fence selected the larger and more perfect posts for this line. Of these 75, 72 are sound, or 96 percent.

These three fences all agree in their testimony that three-cornered heart posts show more decay than the flat ones that were split out next to the sap wood. They also show a greater percent of sound posts among those that are set with the top up than those set with the top down. The cause for this would seem to be that the post at the top end is a little smaller and therefore does not last quite as long. In oak posts split from large trees, where the taper of the post is not so evident, this difference in durability is not so noticeable.

LOCUST No. 13. This fence is interesting as a curio rather than for scientific data of any value. The posts are made from railway crossties that are said to have been put in when the Little Miami Railroad was built. They remained in the road-bed until the track was reconstructed and larger rails were put on. The ties were at that time discarded because they were so hard that the men could not drive the new spikes into them nor pull the old ones out. They were brought up to Xenia by the section foreman and put into the present position. These posts serve to show that some posts or ties of locust will endure for a remarkably long time; but they are not worth much as data upon which to estimate the durability of timber, because it is not known how many had rotted by the side of these in the track.

LOCUST No. 20. This is a garden fence in which are locust and red cedar, both of first quality, and the two kinds show the same percent of sound posts. The cedar posts are recorded in red cedar fence No. 20.

RED CEDAR No. 2. Compare this fence with red cedar No. 26. No. 2 has 74 percent sound in 11 years. No. 26 has 85 percent sound in 62 years. The posts in No. 26 are slightly larger, although those in No. 2 are good sized posts, having from 4 to 6 inches of red wood.

The wood in each case was pure, healthy growth, no indication of doted wood when posts were set. When two fences of the same kind of wood differ as widely as these when both are made of healthy wood, there is a financial or economic matter involved, that should call forth our closest scrutiny.

The posts in No. 2 grew in the open and have from 4 to 6 annual rings to the inch. Those in No. 26 have from 50 to 60 annual rings to the inch. The rings are so close that the microscope had to be used to count them (see Plates IV and V).

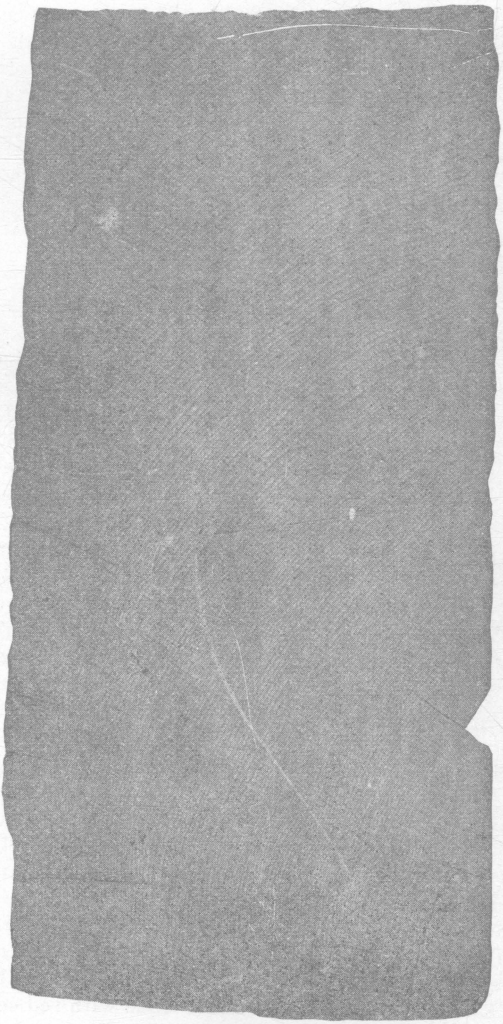

Plate IV. Cross-section of a red cedar post, sound after 62 years in the soil. The cut is the same size as the block from which it was taken. At one corner of this block there are 68 rings to one inch.

RED CEDAR Nos. 13 AND 15. No. 13 is 18 years old and about 76 percent sound. No. 15 is 40 years old and has 75 percent sound.

No. 13 has from 6 to 11 rings to the inch. No. 15 has 30 to 50.

In this case the two fences are on the same farm and begin within a hundred yards of each other. One is more than twice as old as the other, but the percent of sound posts is almost the same. Red cedar that grows in the open has wide annual rings, is apt to have large and numerous knots, a very thick sap wood, the red is not as deep color, and usually has more of those pale red or almost white spots that are commonly mixed in with the heart wood of this tree. This quality of post has been observed, a few at a place, at numerous places over the state, and they regularly show poor record. The red cedar fences, however, where there is a considerable number of posts in one string, are usually made of those that have been shipped from where they grew in the timber.

The above characteristic has been watched quite closely throughout and it is observed to be quite a regular law that the closer the rings the better the quality for posts.

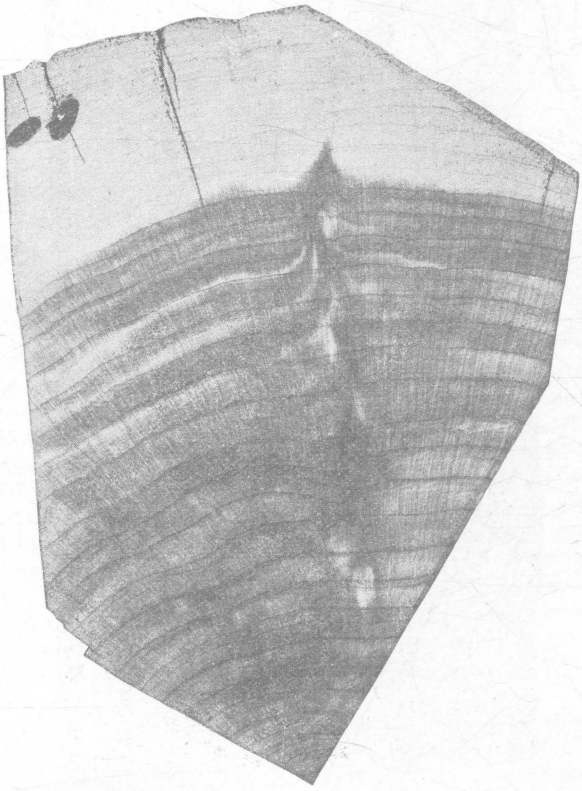

Plate V. Cross-section of a red cedar post that was rotten in 9 years. Cut was reduced one-third in diameter from the block of wood. The rings on the wood are just 4 to the inch. See pages 622-624.

RED CEDAR No. 20. These posts are set alternately with locust and have the same percent sound as the locust. Described under locust fence No. 20.

RED CEDAR No. 21. Fence is only 7 years old but is showing considerable decay, 7½ percent. Posts grew in an old field but in some places with rather thick stand. Rings are from 9 to 12 to the inch. Posts were cut in April.

RED CEDAR No. 22. Came from same grove as those in No. 21 but from denser portion. Most of these have about 20 rings per inch. The posts also average larger. Posts were cut in January. They are all sound at 12 years, while those of fence No. 21 have 7½ percent rotten in 7 years.

MULBERRY No. 1. These posts are set alternately with native-grown white cedar, 40 posts of each kind. Mulberries 72½ percent sound, cedar 77½ percent sound. The mulberries are of only moderately good quality. Compare white cedar No. 1.

MULBERRY No. 2. Posts here are of very fine quality. Note the difference between this and fence No. 1. No. 1, 19 years old, 73 percent sound, No. 2, same age, 95 percent sound. These posts were clear, bright yellow, while those in fence No. 1 frequently were too dark in color and had more little defective places. Some of them seem to have been split from trees on the decline. So much for good quality.

MULBERRY No. 3. Are set with white oak. Mulberry 85 percent sound, oak 73 percent. Mulberry posts were made from dead trees, quality not very good; cf. oak fence No. 9.

MULBERRY No. 4. A yard fence with 88 mulberry posts and 31 oak, each of good quality of its kind, each kind seasoned about one year. Mulberry 65 percent, oak 32 percent sound. This fence is a very important one, because the two kinds have had the same treatment and each is a good specimen of its kind.

MULBERRY No. 5. Fence is a mixture of mulberry and catalpa, in which the mulberry seems to be the better, each a good quality of its kind. Mulberry 61 percent, catalpa 53 percent sound; cf catalpa fence No. 24.

MULBERRY No. 6. A mixture of mulberry and catalpa in which the catalpa has the advantage. The mulberry is not a good quality of its kind. Mulberry 40 percent, catalpa 85 percent sound; cf. catalpa No. 33.

MULBERRY Nos. 7 AND 9. Mixed with catalpa, in which mulberry shows the better record. The mulberries 64 percent and 59 percent sound, catalpas 52 percent and 39 percent sound,

WHITE CEDAR No. 1. Fence contains 40 white cedar and 40 mulberry. Cedar, 77½ percent sound; mulberry, 72½ percent sound. See mulberry fence No. 1.

WHITE CEDAR Nos. 2, 3 AND 4. A large number of these posts are halves sawed from small sized trees. Those marked "p" and "f" usually show that decay began at the heart. Quite frequently, all that is left of the post where it enters the ground is a half-circle next to the sap wood. See Plates I and II.

A considerable portion of these posts had what is known as "pipe rot" when set. "Pipe rot" is a term applied to white cedar that has a little doted place or a little hollow about an inch in diameter extending through the length of the post. This is very frequent with the white cedar and dealers in selling sometimes specify that "pipe rot" shall not be considered a defect such as to bar the post thus affected from the first class.

WHITE CEDAR No. 6. All the rotten posts in this fence were removed in the summer of 1907, and locust put in their places. The locusts were taken from the east line of the farm, from a fence that was built in 1874, along a lane. The lane was abandoned in 1907 and the locust fence was moved out onto the line, and wire was put on instead of the old boards. Thus fewer posts were used. The posts that were brought over to the white cedar fence were set with the same end in the ground as in the former fence. The condition of the locust fence may be seen in locust No. 7, which was 32 years old and had 69 percent sound.

CATALPA No. 2. The posts in this fence were hewn from small trees that were mere bushes when the other timber was cut off. They were left and grew thus in the open, in rich, bottom land. They were all pure heart wood with no decayed places. The owner thought when he finished this fence that he would never have to build another in the same place. But it all went down in eleven years.

There were short posts set alternately with the regular posts. These just came to the top of the base-board of the fence. These short posts were cut from slow growth catalpas in the woods; some of them were pieces of old posts. A good percentage of the short ones were sound when the fence was removed. See Plate VI.

CATALPA No. 5. Age 18 years. The north end of this fence originally contained catalpa, mulberry, burr oak, honey locust, and sassafras. The honey locust and the sassafras are all gone. Of the other three kinds, the owner says he has taken out more oaks than any other. The south half of the fence has never had any posts removed. They are mostly catalpa and mulberry. The mulberry is in a little better condition than the catalpa.

CATALPA No. 9. Age 14 years, 66 percent sound. These are alternate with locust in fence No. 1 under locnst, and are discussed there.

CATALPA No. 12. Age 5½ years, 25 percent sound. These were cut from trees that grew in low rich land, just inside of a field, along a road. The growth was very rapid, the annual rings frequently being three fourths of an inch thick. The posts were cut just as the buds began to swell, and set green.

CATALPA No. 13. Age 15 years, 86½ percent sound. These posts stood 15 years, then were turned over and the other end was put in the ground. The exact condition therefore for these first 15 years can be seen by looking at the top of the present posts. Very few posts were discarded in resetting. If a post had rotted off in the 15 years, a piece was nailed on the top of it when reset. Posts are of fine quality, with close grain.

CATALPA No. 14. Age 21 years, 60 percent sound. Is a continuation of fence Nor 13, but this part has never been reset nor mended. It stood six years longer, or 21 years and shows 60 percent sound as compared with 82½ percent sound in the 15 year-old fence.

CATALPA No. 19. Age 13 years, fence contains 42 catalpa and 62 oak posts, catalpa 69 percent and oak 40 percent sound. Each kind only medium in quality.

CATALPA No. 22. Age 25 years, 67 percent sound, is a fine quality of catalpa grown in dense timber. No posts have ever been removed from fence. Some of these posts sent out sprouts as they stood in the fence. One of these was left and is now a tree about 40 feet tall. Posts were cut in the winter and set green. Compare catalpa fence No. 12.

CATALPA No. 25. Age 13 years, 43 percent sound. Posts were cut April. They show poor record, only 43 percent sound in 13 years though t were a good quality of timber, close grain. Compare catalpa No. 12.

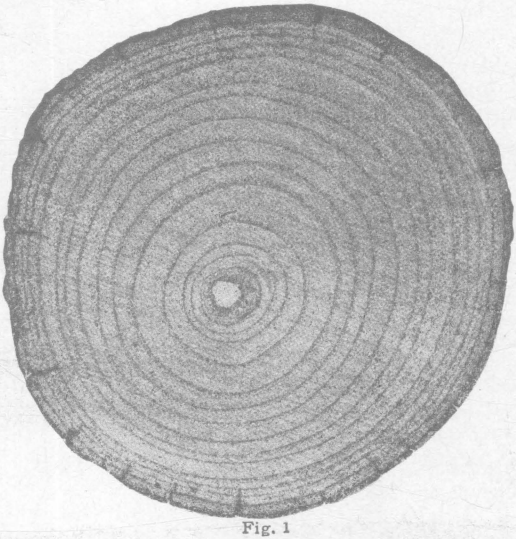

Fig. 1

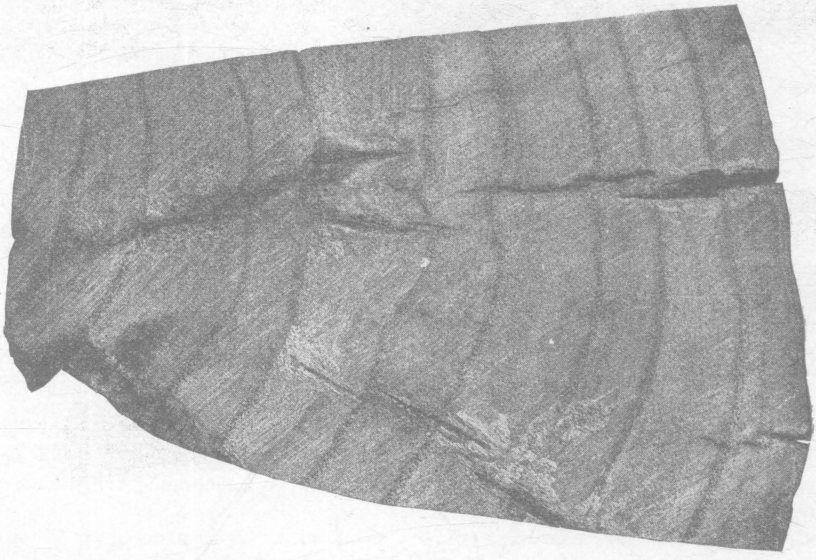

Fig. 2

Plate VI. Fig. 1, Cross-section of a catalpa post, sound after 15 years in the soil. Note how close the annual rings are. See page 626. Fig. 2. Cross-section of a catalpa post rotten in 6 years. Note the large annual rings.

CATALPA Nos. 27 AND 28. Age 13 years, 43 percent sound, and age 16 years, 9 percent sound. Many of the posts in these two fences have annual rings on the outside about twice as thick as the average thickness for trees grown in dense timber. These posts were made from trees that grew in their early life among other trees which were afterwards cut away, leaving the

catalpa in an open woods. That part of these posts, therefore, which in other posts is best, that is, the part next to the sap wood, shows rapid growth. This may be the cause of the poor record in these two fences. Some oak posts in No. 28 are 35 percent sound, while catalpa in same fence are only 9 percent sound.

CATALPA No. 35. Fence contains mulberry posts also, that show 59 percent sound, while the catalpas show 39 percent sound. Has never been reset. Each is good quality of its kind; cf. mulberry No. 9. Both kinds were seasoned.

CATALPA No. 38. Is the same fence as catalpa No. 4, but one year later, showing 53 percent sound as against 62 percent sound one year before. Seasoned.

CATALPA No. 41. In same fence are 48 posts of fine quality of white oak. No posts have ever been removed. The catalpa shows 77 percent sound, the oak 44 percent; cf. oak fence No. 17. Age 20 years, well seasoned.

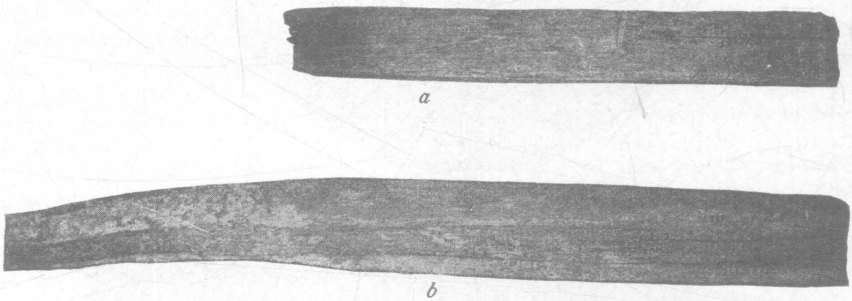

Fig. 1

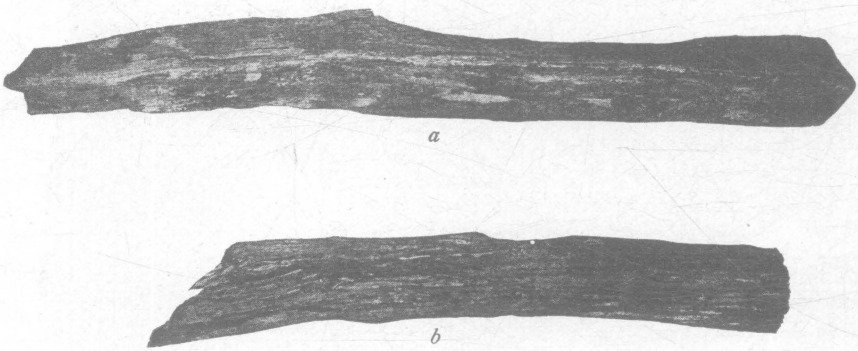

Fig. 2

Plate VII. Fig. 1, (a) Catalpa post from a fence eleven years old and all rotten. Posts in this fence are from trees of rapid growth. (b) Catalpa post from a fence 25 years old. Two-thirds of the posts are sound. Trees from which the posts were made grew very slow in dense forest.

Fig. 2, (a) Locust post from fence 6 years old, rapid growth. (b) Locust post from a fence 31 years old, slow growth. The two fences have the same percentage of rotten posts. See page 639.

CATALPA Nos. 53-84. All the catalpa posts in fences 53-84, 8514 in number, were grown in cultivated groves. They are all round and small, from 2½ to 5 inches in diameter at the ground. The great mass of them are between 3 and 4 inches in diameter. They were grown in Kansas, with a few exceptions in the Farlington, the Hunnewell, and the Munger plantations. The posts at the top end have from 13 to 20 annual rings, usually about 15 or 16. These rings are much wider near the center than near the bark. The first 3 rings are frequently about ½, ⅓ and ¼ inch thick; whereas on the outside it takes 8 to 10 to make an inch. See Plate VI, Fig. 1.

The trees from which these posts were cut were planted 4 x 4 feet, and after the first few years there was of course intense crowding. This caused the outer layers, the outside half of the post, to have about the same rate of growth and same texture as that grown in native woodlands in the Wabash valley. Since the posts are all round, that part of the post that grew slowly is next to the soil.

The sap wood of the catalpa is confined to the two outside rings. This holds good for the thrifty and the crowded tree alike. The thickness, therefore, of the sap wood in these posts is a mere trifle, frequently not more than the tenth of an inch; and although the post may seem quite small, still it has a comparatively good amount of serviceable heart timber.

There is a good lesson for the tree grower in this; that is, when a grove begins to get crowded and the trees are growing more slowly, they are probably putting on a better quality of post material, and besides, the increase of serviceable post timber is more than the current year's growth would indicate.

Let us suppose that on a given tree the annual rings for the years 1906, 1907, 1908, 1909, are 1-6, 1-7, 1-8, 1-9 of an inch in thickness.

These rings represent the amount of growth of the tree in the respective years, but the layer 1-6 of an inch thick was changed to heart wood in the year 1908 and the layer 1-7 of an inch thick will be changed to heart wood or serviceable wood in 1909. The increase of serviceable wood therefore for the years 1908 and 1909 is the amount that grew in the years 1906 and 1907.

So far, therefore, as these two points are concerned, it would seem advisable to let a grove stand a few years after it has become crowded.

CATALPA No. 72. These are mere stakes, about 2½ inches in diameter, all round. They were cut from little trees 7 years old. They have been in the ground 6½ years and are 64 percent sound.

This should be compared with catalpa fence No. 80, in which the posts are but little larger, 2½ to 3 inches in diameter, but were cut from trees 13 to 14 years old, growth about half as rapid as those in No. 72. Fence No. 80 is 8 years old and has 83 percent sound.

CATALPA Nos. 85-93. The posts in catalpa fences 85-93 were cut from trees that grew in Ohio in cultivated groves.

CATALPA Nos. 86 AND 88. Notice here that fence No. 86 is 11 years old and 100 percent sound and that No. 88 is only 6 years old and only 87½ percent sound.

The posts in No. 86 are very small but they are made from very slow growing trees. Those in No. 88 are from fast growing trees.

CHESTNUT No. 1. These posts are set alternately with white oak of about the same size, Chestnut 83⅓ percent sound, oak 82 percent sound; cf. oak No. 3.

CHESTNUT No. 14. Fence contains 58 chestnut and 13 oak posts, about same percent of each sound. The oak were of poor quality.

OAK No. 2. Age 9 years, 59 percent sound. Two years after this fence was examined so many of the posts were rotten that the fence had to be reset. The first eight posts at the north end of the fence are good quality of locust, one of which is rotten. These locust posts are now standing with the fourth set of oak.

OAK No. 3. Posts are 82 percent sound, set alternately with chestnut 83⅓ percent sound.

OAK No. 9. Mixed with mulberry. Oak 73 percent, mulberry 85 percent sound.

OAK No. 10. Is mixed with mulberry No. 4, age 20 years. Oak 32 percent mulberry 65 percent sound.

OAK No. 12. Most of the rotten posts here are three-cornered heart posts.

OAK No. 14. Age 23 years, 90 percent sound. These posts are made from the chinquapin oak, or white barked chestnut oak. Posts were put in the ground the same day they were split. It is a rather remarkable record for oak. They are of very fine quality.

OAK No. 15. Posts are set with catalpa in which catalpas are 69 percent and oaks are 40 percent sound; cf. catalpa fence No. 19.

OAK No. 16. These are set with catalpa that has rather rapid growth on outside of post. Catalpa 9 percent sound, oak 35 percent sound. See catalpa fence No. 28.

OAK No. 17. Catalpa and oak mixed. Catalpa 77 percent, oak 44 percent sound. Good quality of each kind. See catalpa fence No. 41.

OAK No. 18. This fence is given in detail in Tables III and IV. It will be noticed that three-cornered, heart posts here show poor record. These three-cornered ones are quite large in this fence.

There are four round sassafras posts here, Nos. 137, 143, 144 and 145. They are seven or eight inches in diameter, one is sound, three are rotten.

OAK No. 19 Age here is a little uncertain, but these are very fine quality of oak.

OAK No. 22. Fence contains 143 good quality red cedar and 75 oak posts. Cedar all sound, oak 71 percent sound. See red cedar fence No. 24.

OAK No. 23. Set with chestnut. Oak 39 percent; chestnut 38 percent sound. See chestnut fence No. 14.

HONEY LOCUST No. 1. Age 15 years, 34 percent sound. This is the only fence of honey locust of any considerable length and age that has been examined. They have been found, a few at a place, in several other fences, and have shown poor record.

BLACK ASH FENCES. I find a number of men who speak very highly of the black ash for post timber, but the fences and telephone lines in the northwest part of Ohio do not seem to justify this estimate.

In making an estimate of the worth of a given timber, several things should be considered.

It has been pointed out above that posts are frequently set that are in poor condition when set, that is, they may have been grown or cut under unfavorable conditions, or they may be too dark in color, not entirely healthy, or even doted to a considerable extent.

Fences that are made in part or entirely of such posts are not so valuable for data, since there is no means of estimating to what extent they are defective.

They may be used to show the tendency of such timber to be thus affected.

Thus for example locust fence No. 4 should be rejected in making an estimate, because the posts were of very poor quality, some of them even beginning to decay when they were set. In 6½ years 18 percent of these were rotten.

Locust No. 13 contains 20 posts that have been in service for probably 60 years and are all sound. This should not be counted in making estimates, for these were made from old railroad ties and, though these 20 show remarkable record, yet there is no way of knowing how many rotted by the side of them in the track. It would be just as fair to gather up the rotten, if that were possible, and estimate the locust from them.

Catalpa fence No. 12, which at the age of 5½ years had only 25 percent sound posts, is an extreme case. It contains two suspicious elements, very rapid growth and posts were cut just as buds began to swell.

Catalpa fences Nos. 72 and 73 should be rejected, because the posts are so small and grew rather fast, and had but little heart wood. These contain 64 percent and 75 percent sound.

Osage orange Nos. 20 and 21 should be rejected on account of large size, being from 6 to 12 inches in diameter. These are 58 and 48 years old, respectively, and none are rotten.

Red cedar No. 2 contains only 74 percent sound posts in 11 years. It should be taken into consideration where these grew, that is, out in the field.

Red cedar No. 17, 50 percent sound in 63 years, should be rejected on account of size. They are about a foot square.

Fences therefore that are to be used as a basis for conclusions should contain posts made from average timber and should contain a goodly number of posts.

The following tables contain the data on a few characteristic fences. Each fence is a good example of its kind, and none are put in this list except those on which very accurate data could be obtained. They are average fences in which the posts were sound when set. Each group will therefore reflect a comparatively correct estimate of the kind of posts that it contains.

Age of Fence	Number sound posts	Number rotten posts	Total	Percent sound
OSAGE ORANGE				
28	53	1	54	98.1
33	494	2	496	99.6
29	310	2	312	99.3
36	38	1	39	97.4
40	49	0	40	100
33	17	0	17	100
Average Age, 33.2	Average Percent Sound, 99			
LOCUST				
31	22	3	25	88
32	115	51	166	69.3
20	126	30	156	80.8
21	143	13	156	91.7
22	111	21	132	84.1
30	55	6	61	90.1
22	88	34	122	72.1
Average Age, 25.4	Average Percent Sound, 82.3			
RED CEDAR				
35	24	27	51	47
42	81	59	140	57.9
36	37	29	66	56.1
30	48	13	61	78.7
18	71	22	93	76.3
38	57	19	76	75
Average Age, 33.2	Average Percent Sound, 65.2			
MULBERRY				
19	29	11	40	72.5
20	57	31	88	64.8
19	20	2	22	90.9
24	10	7	17	58.8
37	41	8	49	83.7
Average Age, 23.8	Average Percent Sound, 74.1			
WHITE CEDAR				
17	122	44	166	77.5
17	174	72	246	71
15	84	7	91	92
25	33	26	59	56
18	31	39	70	44
Average age, 18.4	Average Percent Sound, 68			
CATALPA				
25	14	7	21	66.6
17	55	34	89	61.8
20	30	30	60	50
14	43	34	77	55.8
21	47	31	78	60 2
25	57	28	85	67.1
22	26	29	55	47.3
13	37	49	86	43
14	103	24	127	81.1
15	69	54	123	56.1
7	463	45	508	91.1
Average Age, 17.5	Average percent Sound, 61.8			

Age of Fence	Number sound posts	Number rotten posts	Total	Percent sound
CHESTNUT				
11	57	24	81	70.4
9	116	49	165	70.3
13	61	17	78	78.2
16	171	102	273	62.7
12	42	11	53	79.2
13	77	33	110	70
Average Age, 12.3	Average percent Sound, 71.8			
OAK				
9	57	40	97	58.8
17	38	30	68	55.9
14	49	21	70	70
13	145	97	246	58.9
8	43	13	56	76.8
10	53	22	75	69.7
Average Age, 11.8	Average Percent Sound, 65.2			
BLACK ASH				
7	38	20	58	65.5
6	17	10	27	62.9
Average Age, 6.5	Average Percent Sound, 64.2			

It is practically impossible to arrange a set scale of percents that will show the exact value of each kind, on account of varying circumstances surrounding the fences. For example, one fence may contain posts of the very best quality of their kind while another of another kind may contain a second best. Then there are all stages of seasoning, and different kinds of soil. Then, too, the age of a fence and the percent of rotten posts do not increase at the same rate.

While, therefore, in the tables above, the average age and the average percent sound cannot be regarded as scientifically accurate, yet it is felt that they give a fair idea of the durability of the various kinds.

In the following table an effort is made to picture the relative value of the different kinds of timber by giving the percent of posts that are usually found to be sound at various ages, beginning at ten years and counting each five succeeding years up to 50 years.

When the number of sound posts falls below 50 percent, no further notice is made of it.

This table probably shows the best comparative estimate that can be given.

PERCENTAGE OF SOUND POSTS IN AVERAGE FENCES AT AGES FROM TEN TO FIFTY YEARS

Age in Years	Osage Orange	Locust	Red Cedar	Mulberry	White Cedar	Catalpa	Chestnut	Oak	Black Ash
10	100	100	100	97	85	90	72	71	40
15	100	95	97	80	78	72	62	61	
20	100	89	87	78	62	58		47	
25	100	(86)	(84)	73	65	53		62	
30	99	83	80	62		45			
35	98	(79)	55	85		50			
40	97	83	70						
45	100								
50	100								

The numbers in parentheses are in part or entirely estimated from the numbers preceding and following; for example, it so happened that there were no locust fences examined that were exactly 25 years old, and the percent sound for this age is estimated at 86, which is half way between 89 and 83, the percentage for 20 and 30 years respectively.

It will be noticed that in each column the numbers representing the percentage of sound posts decrease to a certain point and then increase again; for example, the column under "Red Cedar" decreases until age 35 is reached. We find the average fences at this age are 55 percent sound, while the average fences at 40 years of age are 70 percent sound.

The cause of this unexpected feature is that the posts are large and of exceptionally fine quality with practically no defective posts. The important part of the table is that before this increase in percentage takes place and for this reason the first or important part is printed in bold face type.

Fences of these older ages have been found as recorded, and although they are not the types that estimates should be made from, yet it was thought best to put them in the table, but they have been put in with a different kind of type. One very important lesson that they teach is the effect brought about by the selection of good quality of perfectly sound timber.

It will be seen from the table that the Osage orange is in a class entirely alone, with no close competitor. Yellow locust and red cedar come next, very close together, with a little in favor of the locust. In the case of the red cedar, only that which grew in the woods is counted. That which grows in the open is about the same as oak in durability. Considerably below these two is mulberry. Then white cedar and catalpa quite close together; and below these, chestnut and oak, with a little in favor of chestnut; then black ash. The varieties of oak counted are white oak, chinquapin oak, burr oak, the majority being white oak. A small amount of black oak and post oak has also been examined.

Besides these varieties there have been found a few at a place of honey locust, sassafras, black walnut, white walnut and elm. The durability of these is usually poor; though some instances of excellent durability have been found in the black walnut. It is regularly poor when cut from a thrifty young tree.

The durability of some timbers seems to have been over estimated; for example, the chestnut and the hardy catalpa, especially the latter.

The author is aware that most writers on this subject class the hardy catalpa with the red cedar, the yellow locust, and the Osage orange, but the examination of 292 fences containing 30,160 posts in actual service points to the conclusion herein made, and the classification has been made in accordance with what the data indicate, regardless of any personal opinion. The fences examined were the oldest that could be found.

It is suggested that the former estimate placed on the durability of this timber seems to have been taken in a large measure from isolated posts, from old logs pulled out of river beds where they had lain for many years, or from railroad ties where no record is given of those that may have rotted in the same track while these survived. A dozen ties that have survived 25 or 30 years in the road-bed of a railroad are worth but little for data unless it is known how many of the same kind rotted in the same situation. A dozen posts that have survived 40 years in a fence are worth but little for data, unless we know the condition of all the other posts in the same fence.

Let us illustrate with a timber that we are all acquainted with. Near Albion, Illinois, there is a gate post that was an old weather-beaten post when the present owner bought the farm, just before the Civil War. This post was still supporting a gate in the summer of 1906. Near Lebanon, Ohio, is a post which supported a gate, or gates, 65 years and was then run against by a two-horse wagon, owned by the grandson of the man who set the post. It stopped the wagon and was not broken. These two posts are white oak.

At the Ohio Experiment Station, at Wooster, Ohio, is a piece of white oak timber a foot square. This piece was one end of a log 60 feet long. The entire log is sound, showing practically no decay at any point. This log has been under ground ever since the Wabash Canal was built. It was under water most of the time.

It is evident that an estimate of the durability of white oak should not be made from these three instances.

The fact should be kept very clearly in mind that *in order to have reliable data, we should have a number of fences with a considerable number of posts in each, and the condition of every post in the fences should be taken.* It would be just as fair to gather up the rotten ones and make an estimate from them alone, as to take the sound ones that have survived and make no note of the rotten ones

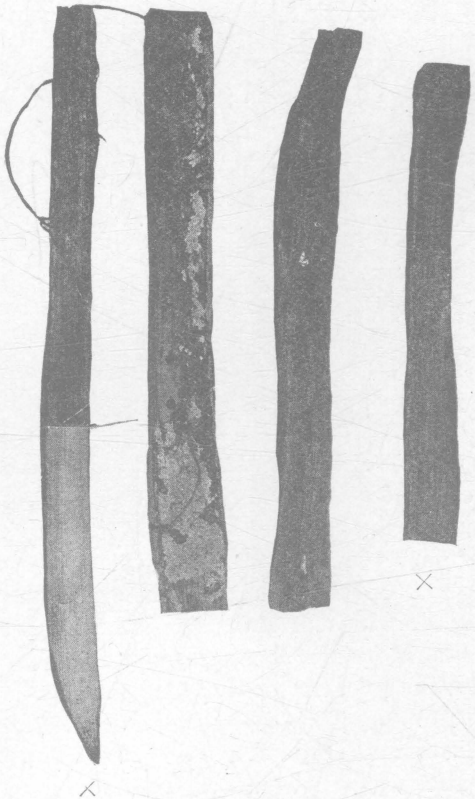

Plate VIII. Parts of two Osage orange posts, from two fences, one 30 and the other 34 years old. Each fence contains a little over 99 percent sound posts. This is about an average for the Osage orange. The pieces marked X are the parts that were in the ground. See page 620

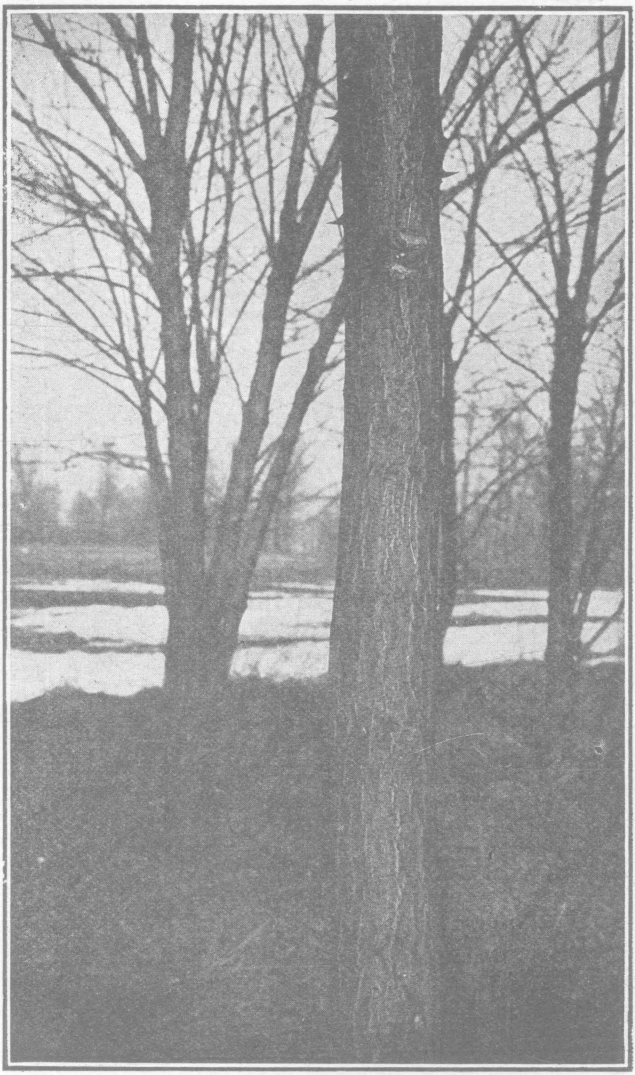

Plate IX. The trunk of a healthy young locust tree. Note the lighter colored places between the longitudinal ridges.

Plate X. The trunk of a locust tree affected with the locust borer. Notice the lumpy, uneven surface and that the bark is all dark. Compare this with Plate IX.

SOME FACTS BROUGHT OUT BY THIS INVESTIGATION

1. That a large post usually lasts longer than a small one of the same wood.

2. That there is no difference which end is put in the ground, except that the sounder or larger end should have the preference.

3. In stiff clay soil, the posts rot principally just beneath the top of the ground, and in a porous sandy or gravelly soil, they usually rot from the top of the soil all the way down; the effect is the same in both cases.

4. In soil that is full of water all the time, posts will last longer. It is the alternating between wet and dry that causes decay.

5. From data collected so far, seasoning does not seem to have any marked effect on durability. The best catalpa fence examined was set green; cf. catalpa fence No. 8. In the best oak fence examined, the posts were cut and put in the ground the same day; cf. oak fence No. 14. Likewise some of the best fences are those in which the posts were well seasoned.

It has been very difficult to get accurate data on the matter of seasoning, especially in fences where the posts have been only partially seasoned when set. But there has been a sufficient number found, in which the posts when set were well seasoned or entirely green, to justify the above conclusion. We hope, however, to be able to investigate this matter further.

6. Timber that grows rapidly and in the open is not as good as the same variety that grows in the woods. This has been observed especially in the red cedar, the catalpa, and the locust. Compare red cedar fence No. 2, 11 years old and 74 percent sound with red cedar No. 15, 40 years old and 75 percent sound; No. 2 is from rapid and No. 15 is from slow growing timber. Compare catalpa fence No. 2, 11 years old, all rotten: No. 12, 5 1-2 years old, 25 percent sound; No. 28, 16 years old, 9 percent sound; No. 72, 6 1-2 years old, 64 percent sound with catalpa No. 8, 31 years old, 88 percent sound; No. 13, 15 years old, 86 percent sound; No. 22, 25 years old, 67 percent sound. Compare locust No. 4, 6 1-2 years old, 82 percent sound with locust No. 9, 21 pears old, 91 percent sound. See Plates III, IV, V, VI and VII.

7. There is some evidence that it is not a good time to cut posts just as the tree begins to grow in early spring. This was noticed especially in catalpa fences Nos. 12 and 25 and to some extent in a number of others.

8. The wood at the center of the tree is not as good as that just inside the sap wood. This characteristic is very common with nearly all the varieties of timber examined, especially so with the locust, the white cedar, the hardy catalpa, and the oaks. See Plates I and II.

9. The quality of the wood or the condition of the wood fiber of a post is a very important item in its ability to endure in the soil. In an average lot of so-called first class posts on the market, usually a number can be selected that are defective, though they may appear sound and firm. This quality of post is usually somewhat darker than the usual color, especially near the center of the tree.

At the State Experiment Station at Wooster, Ohio, there are on file the data of every fence that was examined in this investigation. These data contain, among other items, the name and address of the owner, the location of the fence on the farm, and the date the fence was examined. Any one who feels inclined to examine any of these fences that happen to be in his community can get their location by writing to the Forestry Department of the Experiment Station.